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Objectives of a Taxonomic Catalog of Coleoptera[1]

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The leaders of modern biology have for many years glamorized some kinds of research, especially research using sensitive measuring devices. Their collection of adjectives describing this work is rivaled only by commercial advertising. They have succeeded in luring many of our best students into three specialized areas of biology which have since become highly competitive, low data-yielding, and very restrictive. These areas are molecular, cellular, and developmental biology. Interesting as they may be, they are no more dynamic than that less specialized, high data-yielding branch of biology which has suddenly become very popular, environmental biology. However, if some branches of biology are able to attract students, it is because it is made interesting and challenging. The environmental biologists, until recently, have failed to do the same, mainly because they have not seen how their premises, procedures, and product fit into the scheme of biology, and they seem to fail to see that this now, suddenly much needed area, has glamour and value.

A taxonomic catalog of organisms looks to be far from any of these biological worlds, yet, catalogs are a vital part of several coordinated projects needed for any environmental study, for all must deal with organisms as a part of the environment. The populations of these organisms, the species they form, and even their adaptive evolution, are first considerations in all environment studies.

In order to appreciate the processes, balances, and checks operating in the effective environment, one must know not only the orders and families that occur in the habitats, but also the species and their populations. There is no such thing as the biology of an order, or the ecology of a family. Neither families nor genera function in an environment. Only the individual of a species have functions. It is impossible to experiment with the genetics of a family or a genus. The environment or habitat of a family cannot be known. Selection takes place only through individuals and it is only the progeny of individuals that can evolve. Since individuals usually mate only with other individuals of their own species, it follows that information gathered about individuals as members of a common gene pool may be extended within the confines of logical scientific procedure to apply to a population. Accuracy of these studies must be dependent upon the accuracy of the identification of the populations of the organism. This must start with taxonomic information packages about species, and taxonomic information retrieval begins with a descriptive catalog!

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How can cataloging be a dynamic, interesting, and a challenging part of environmental biology? After all, it deals with nothing but ancient literature, long since useless and generally superseded by more modern works, or so it would seem. The one way to make it interesting is to relate taxonomic data to natural, living populations as they occur in the field. Since population biology is one of the areas of current interest, the objectives of a catalog should relate population and environment. A handbook of the proper nomenclature of North American Coleoptera, for example, could refer directly to the beetle populations by restricting, so far as possible, the nominal population (=type) locality, and indicating the range of the concomitant populations. (These terms are defined later in this paper). The researcher may then make his identifications and relate the data on the populations with these names, as well as with the previously published data. Details of this method have been outlined by the author previously (Arnett, 1970a).

A further objective of a catalog is to provide a checklist of the species of more restricted areas for the use in faunistic studies. These two objectives are considered in particular and in some detail in the sections that follow.

The arrangement of species by distribution areas described below is an innovation proposed only after considerable study and weighing of many factors. It is not yet possible to arrange species by natural faunal areas, and it is problematical if this ever will be done. Fauna regions, as opposed to geographical regions, have certain inherent difficulties. The habitat requirements of the species of most genera of any region are varied; this is a biological requirement, and a part of any species isolating mechanisms. But, even so, certain trends are evident in some or most of the well defined genera so far as the actual geographical distribution of the species is concerned. This has enabled me to devise the system proposed here, based on political boundaries which obviously have little natural basis. Some habitats coincidently are roughly outlined by these regions so that the areas selected do approach our original hope to some extent for a system of natural faunal areas. For example, area 6, the arid southwest, is approximately equal to the western arid region. Examples of this kind of distribution pattern can be found in many groups.

The usefulness of this politically based system are several. For example, it may be of service to those involved in pest management projects confined to a single state. Regional handbook preparation is facilitated by such a list. The reduction of the large genera into smaller units by regions greatly aids one to comprehend the fauna. It eliminates also the confusion of dealing with closely similar species because the most easily confused species generally are found in separate regions. If this system is accepted and used for faunistic studies, it should help to bring the alpha taxonomy of these areas to more rapid completion and open the way for more detailed studies of the beetles of those regions.

A CATALOG SHOULD:

Provide a means of relating nomenclature (or retrieval coding) to the natural species and their populations.

Provide a checklist of the species of more restricted areas for faunistic studies.

GEOGRAPHIC SCOPE

There has never been a complete catalog of the Coleoptera of North America. Previous catalogs have omitted Mexico, mostly because of the limited knowledge, or supposed lack of data, from this large and interesting country. Collecting and research in Mexico since 1945, both by the Mexicans and by visitors from the United States and Canada have brought our knowledge of this region to the point making it possible to write a working catalog of the area. The same is true of Alaska; so that now the geographic scope of a catalog can be enlarged over any previous catalog to include all of the area usually referred to as North America. This usually comprises Canada, United States, and Mexico. However, the remainder of Central America and the West Indies, while not well known, may be incorporated as well. Although Greenland is sometimes considered a part of North America, it is not so regarded here. The islands of Bermuda, and other Atlantic Ocean islands are not zoogeographically a part of this region. However, the Aleutian Islands, and the islands off the coast of California and Mexico are a part.

The areas selected for a faunistic and descriptive catalog appear on the map (fig. 1) and the regions are named and described here. The numbers refer to the region as shown on the map. These numbers are used in the list of species in the catalog as a convenient means of showing additional ranges of a species. In addition, each country and state or province has been assigned a number to be used for computer indexing. These numbers may have associated with them a lot number or locality number for further compact data recording. Thus the range of a species may be coded and retrieved in these three ways.

GEOGRAPHICAL SUBREGIONS OF NORTH AMERICA

1. North Western North America. Western Canada: the provinces of Yukon Territory, District of Mackenzie, British Columbia, Alberta, and Saskatchewan, and Alaska.

2. North Eastern North America. Eastern Canada: District of Keewatin, Manitoba, Ontario, Quebec, Newfoundland, New Brunswick, and Nova Scotia, except for southern Ontario and southern Quebec (see map).

3. Pacific Coast. Washington, Oregon, and California.

4. Northwestern United States. Idaho, Montana, North and South Dakota, Wyoming, Nebraska, Nevada, Utah, Colorado, and Kansas.

5. Northeastern United States and Adjacent Canada. Minnesota, Wisconsin, Michigan, New York, southern Ontario and southern Quebec south of the 47th parallel (see map), the New England States, Iowa, Illinois, Indiana, Ohio, Pennsylvania, New Jersey, northern Missouri (north of the Missouri River; see map), Kentucky, Virginia, Maryland, Delaware, and the District of Columbia.

6. Arid Southwest. Arizona, New Mexico, Oklahoma, Texas, Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas.

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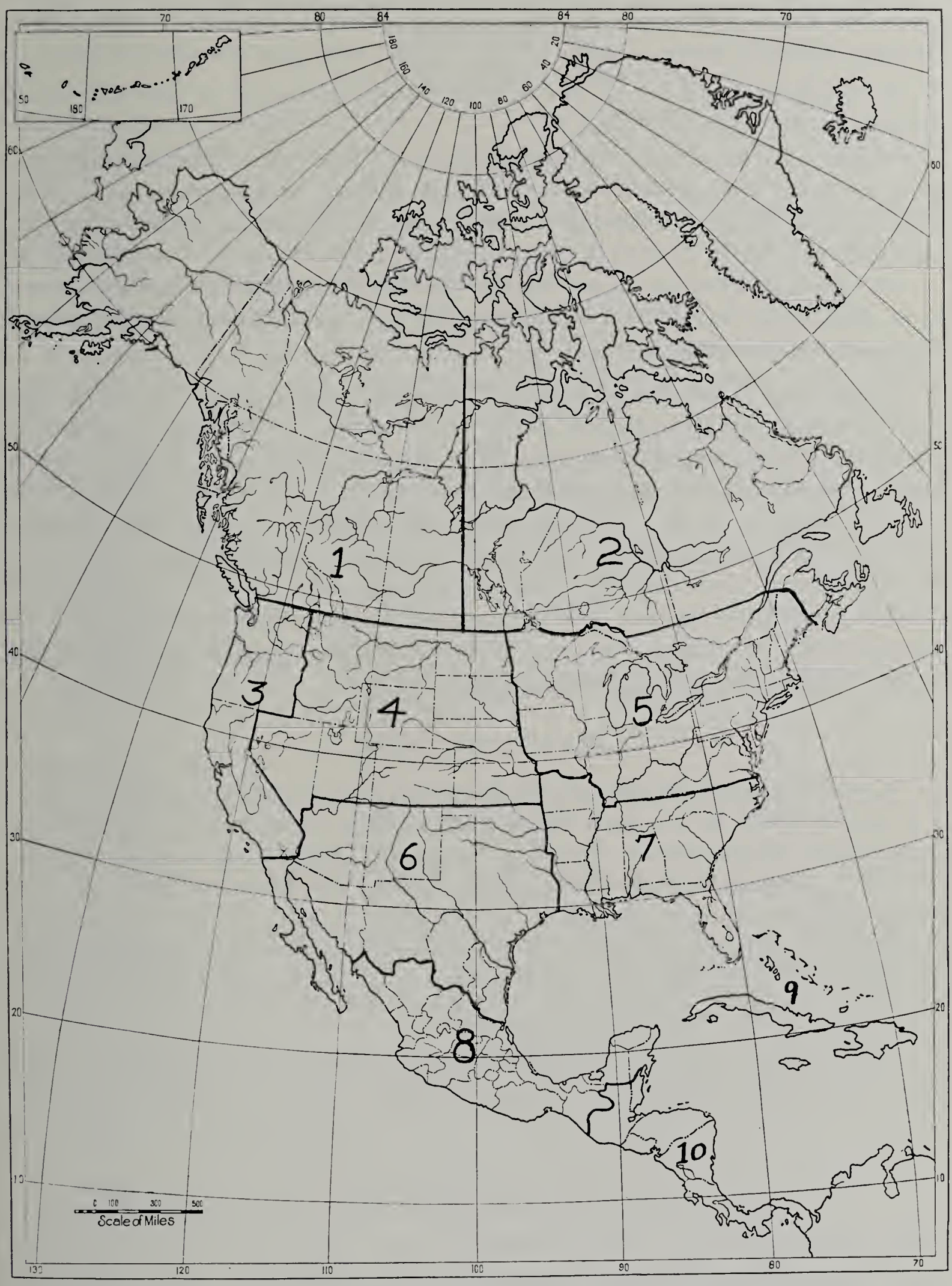

Fig. 1. Map of North America showing regions used for cataloging purposes.

7. Southeastern United States. Southern Missouri (south of the Missouri River; see map), Tennessee, North Carolina, Arkansas, Louisiana, Mississippi, Alabama, Georgia, South Carolina, and Florida, including the Florida Keys.

8. Southern Mexico. All of the states of Mexico south of the arid states included in the Arid Southwest.

9. West Indies. All of the West Indian islands except Trinidad, Tabago, and the Dutch West Indies islands of Aruba, Bonaire and Curaçao. The West Indies are usually divided further as the Greater Antilles and the Lesser Antilles. The latter are further broken into the Leeward and the Windward island groups.

10. Central America. This region includes the countries of British Honduras, Honduras, Guatemala, Nicaragua, Costa Rica, Panama, and the coastal islands of each of these countries.

These areas should be indicated by number and name in a catalog and the species should be arranged under the regions in which they occur. A species that ranges throughout more than one section may be listed as many times as necessary. The range of monobasic species is described by listing each region in which it occurs with details of its distribution under each of these sections. The citation to the original description, other references, and data, are to be given only after the binominal listing under the area in which the nominal population occurs. The preparation of these data for inclusion in a computerized information bank is discussed elsewhere (Arnett, 1970b). An example of this method is shown in figure 2.

BIBLIOGRAPHIC SCOPE

A catalog should include all the literature from January 1, 1758 but only if it was included in the Junk/Schenkling Catalog, the Leng Catalog and its supplements, Blackwelder's checklist, Zoological Record, and other readily available literature sources. No attempt should be made to check beyond these references because no system is available to assure complete retrieval. The obscure literature missed by this arbitrary, but objective, restriction will not yield data of significance. The security of this objective method of work limitation is worth the sacrifice of integrity.

The system of citation of literature is now more or less standard. The author, date of publication, and the page number is given as a reference in the catalog. The full citation is given in the bibliography which follows the catalog proper. The bibliography is arranged alphabetically by author, and actual date of publication. If more than one publication appears during the same year by the same author, each are given a letter (e.g., Smith, 1958a; Smith, 1958b; Smith, 1959, etc.). If the publication date differs from the date printed on the publication, the printed date appears in parenthesis at the end of the citation, but only in the bibliography; the text always lists the actual date of publication. Any annotation of the references other than original descriptions appear within square brackets in the text proper. Distribution of the species may be listed in two ways. It may be restricted to the published records (the best and most objective way) or it may list localities summarized

SAMPLE CATALOG
(Selected species)

Genus **OXACIS** LeConte

Oxacis LeConte, 1866: 165.

Type species: *Asclera cana* LeConte (Arnett, 1950: 223).

3. PACIFIC COAST

(See *O. bitomentosa; O. sericea; O. megathoracica; O. fragilis; O. xerensis; O. pallida,* and *O. nitens.)*

4. NORTHWESTERN UNITED STATES

bitomentosa Arnett, 1960: 35.

Type locality: USA: Nevada, Clark Co., Colorado River Canyon. 3. USA: s. California; 6. USA: w. Arizona; MEXICO: Baja California; Sonora; 8. MEXICO: Sinaloa.

sericea Horn, 1870: 89.

Type locality: USA: Nevada, "central". 3. USA: Oregon, California; 6. USA: Texas; New Mexico; Arizona; MEXICO; Sonora; Chihuahua; Coahulia; 8. MEXICO: Durango.

(See also: *O. fragilis; O. pallida; O. nitens; O. trirossi.)*

5. NORTHEASTERN UNITED STATES AND ADJACENT CANADA

(See *O. trirossi.)*

6. ARID SOUTHWEST

megathoracica Arnett, 1960: 37.

Type locality: USA: Arizona, Yuma Co., Ehrenberg. MEXICO: Baja California; 3. USA: s. California.

fragilis Horn, 1896: 413.

Type locality: MEXICO: Baja California, San José del Cabo. Sonora; USA: Arizona; New Mexico; 3. USA: s. California; 4. USA: s.w. Colorado.

Fig. 2. Sample catalog entries for selected species.

from locality labels on specimens in collections. If the latter method is followed, it is absolutely necessary, if repetition of work is to be avoided, that the collection and date of listing be recorded as a part of the catalog. Obviously, this latter method should be used when writing monographs rather than catalogs. The catalog should not include these kinds of original data. The most useful way of recording distribution is by confining the list to published records, each of which should be cited.

NOMINAL POPULATIONS AND THEIR LOCALITIES

The only way catalogs and the research that is necessary for their organization can have scientific objectivity is through the application of the concept of the nominal population. A *nominal population* is the breeding population to which the holotype specimen belongs. A *breeding population* is a natural population through which there is a free flow of genes. A *natural population* is any assemblage of individuals more or less confined, during their breeding season, to a definite geographical region and a definite habitat. Within the

boundaries of this region there is a free flow of genes among these individuals, thus forming a breeding population. A natural population is one that occurs in a natural environment as opposed to a man-made, laboratory environment. A species is composed of one or more natural populations. The amount of communication between the populations varies from species to species, and this contributes in part, but not entirely, to the variation and degree of discreteness of the species. It is usually only by chance that a population becomes a nominal population; this only because the describer of a species selects a specimen as the holotype. The holotype is a specimen from a population, and by its designation, that population becomes the nominal population. Other breeding populations of the species become *concomitant populations.* The distribution or range of a species, therefore, is the range of the nominal and the concomitant populations.

Past taxonomic literature, and especially catalogs, seldom give the precise location of capture of the holotype specimen. The county, the state, but often only the country, is given as the locality of the holotype and the type series. The task for the biologist interested in these populations and their variation, if he wishes to name them in an objective manner, is to determine the range of the nominal population. This may be done by studying the species and its population to a sufficient extent so that, a) the amount of variation can be determined, and b) the population to which the holotype belongs can be determined. This can usually be done by a statistical study of the variation of the specimens and the placing of the holotype in the proper population according to the way it fits in the variation pattern. There are three possible ways that the nominal population (=type) locality may be indicated: 1) an arbitrary selection of a locality within the known range of the species. 2) The selection of a locality after a study of specimens throughout the range of the species by comparing these specimens with the original description of the holotype and selection of those that best fit. 3) By the same process as the previous, except that the holotype specimen is used instead of the description. Thus, a catalog should indicate the nominal locality shown as: (1) original designation; (2) subsequent designation by holotype; (3) subsequent designation by original description, (4) subsequent designation by arbitrary selection. Whenever possible, the nominal locality should be chosen from an area protected from industrial or agricultural exploitation. Game preserves, state or national parks, national forests, privately protected areas, field stations or biological stations owned by colleges or universities make ideal sites for type localities.

THE LIMITATIONS OF A CATALOG

A catalog is meant to serve the field biologist as a working tool. It is not complete in itself because it can cite only certain types of reference to the various taxa. As far as is known, all original descriptions of the categories genus and species and their infracategories should be cited. Subsequent references are made only when they give additional information about: 1) feeding habits; 2) habitats; 3) morphology; 4) life cycle; 5) behavior; 6) keys or descriptions useful for identification, and 7) distribution.

The type species of the genus is indicated and the method and place of fixation is cited wherever possible, but an attempt to make this exhaustive in the cataloging phase of the study may be impossible and there may be some errors. If, however, the citation of a species as a type of the genus results in many logically unnecessary nomenclatural changes, the changes should not be made in the catalog. This should be explained in all cases, but left for a thorough taxonomic study by a specialist.

All synonymy that is accepted is indicated either as "new synonymy" or the citation is given to show where first placed in synonymy. Synonyms are not accepted if there is doubt about the synonymy in terms of modern population studies. It is felt that it is better to treat doubtful cases as valid species rather than sink them to the obscurity of synonymy without really adequate cause.

Other limitations of a catalog will become apparent only with use. Hopefully, a catalog will be designed for and placed in an information bank. This is a separate topic discussed elsewhere (Arnett, 1970b). The cooperation of the specialists in submitting corrections or mentioning needed changes when they publish their data will be of great value to all biologists.

A catalog cannot contain a discussion of the classification of the order. This must remain for treatment elsewhere at another time. If claim to a reclassification is indicated in the title, it should be through the choice of categories and the arrangement of the various taxa. These changes are best published separately prior to the completion of the catalog.

It may be necessary to produce a catalog in stages. I suggest that parts be issued as compiled, when ready, but with a definite publication schedule. It would greatly speed the work and provide incentives if some systems were used to indicate the stage of refinement of the parts of the catalog. For example, a complete catalog compiled by using only *Zoological Record* references and recent catalogs might be produced and published in a limited edition, printed on pink paper to warn of the danger of its use due to its obvious limitations. As soon as the references are checked with the literature and appropriate adjustments made for any part of the "pink" edition, a new part might be issued in yellow; this "yellow" edition indicating that a further stage had been reached, but the part should be used with caution. The final, revised catalog, following the suggestion made in this paper could be issued on green paper signalling that it can be used as a reliable information source.

CLASSIFICATION CHANGES

As more is learned about any group of organisms, new taxa become necessary. When I wrote the "Beetles of the United States," I was intentionally conservative in the treatment of the family taxa. I now feel that there should be more families recognized if a proper balance is desirable. There is the practical advantage of making small working groups to permit comprehensive treatment of a family-group. Unfortunately, it is still not possible to break into family-groups, the eight largest families, Carabidae, Staphylinidae, Scarabaeidae, Buprestidae, Tenebrionidae, Cerambycidae, Chrysomelidae, and Cur-

culionidae. European workers have broken these families into many smaller ones but without adequate basis unless one is willing to elevate nearly all subfamilies and many tribes to family status. This may eventually be justifiable, but at the present time it seems too radical to be acceptable.

ABSTRACT—The following features should be found in a good classification catalog: All species and infraspecific taxa are listed and arranged by senior synonyms, with complete citations to original descriptions and the location of the types noted. Citations are given for synonymizations, generic and specific. Type species of genera are cited, including those improperly designated, and the method for designation. Taxa are arranged according to an acceptable classification scheme, giving citations to the arrangement followed (new classifications must be documented either in the catalog or elsewhere with citations given). Indication of the geographical range covered, and citations to the source of the geographical distribution information is listed. The bibliographic scope of the catalog, with references to search resources examined, is provided. References to identification keys, useful revisions or reviews, and subsequent descriptions are cited. If the list is selective, an indication of the extent of the omissions should be given. Finally, biological notes are included.

LITERATURE CITED

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(3.0022)

Bionomics of *Merobruchus julianus* (Coleoptera: Bruchidae)

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From 24 June to 4 September 1969 seed samples of *Acacia greggii* Gray were collected in Yavapai County, Arizona, at Black Canyon City, the mouth of Sycamore Canyon, and from four to ten miles south of Camp Verde. The seed beetles *Merobruchus julianus* (Horn) and *Stator limbatus* (Horn) were reared from seeds from all three localities. Observations on the bionomics of both species were recorded during the study and those of *M. julianus* are reported upon here.

Reports of *M. julianus* infesting *A. greggii* have only recently been published (Johnson, 1968) and an earlier host record clarified (Bottimer, 1969). Johnson published information concerning the bionomics of *M. julianus* after it was found infesting *Acacia berlandieri* Bentham. His observations will be compared to our observations of *M. julianus* infesting *A. greggii*.

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